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ABOUT THE COVER Artificial intelligence systems learn much the same way humans do. *See article, page 36.*

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Based loosely on biological intelligence architectures, these artificial intelligence systems actually learn on the job.

PCR Inventor Kary Mullis—Biotech's Untamed Genius 44

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Waste Minimization Starts at the Top 48

Although reducing waste is everyone's responsibility, top management's commitment is key to a successful waste minimization program.

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Remember to fill out the annual *R&D* Salary Survey on page 83. The more responses we get, the better the data. And the better the data, the easier it will be for you to argue for your next raise. Thank you.

R&D BUSINESS

Plastic Waste Needs Technical Answers

Current industrial solutions for handling plastic waste are not likely to be considered as sensible approaches to the problems of waste handling for very long, says Rodney Lowman, vice president for government affairs at the Council for Solid Waste Solutions, Washington, DC.

"Current solutions, such as mandatory recycling or product packaging bans, are expedient solutions to political problems at all levels of government," said Lowman in a speech at the recent National Plastics Exposition in Chicago. "The plastics industry needs to develop and implement long-lasting technical solutions (such as economic recycling and waste minimization) for its waste management problems.

"Plastic waste solutions, for the most part, don't require rocket science-type technical solutions," he says. "These are fundamental materials management problems which involve the challenges of obtaining the least environmental and economic costs to our society.

"Sensitive manufacturers are already feeling the pressure and are demanding products with ultimate disposal in mind," he says. □

States With Basics Are More Competitive

If your home state has not already invested in economic fundamentals, it is likely to suffer more during the current recession than states that did invest, and it will have less success in global trade than other states, according to a recent report, *The 1991 Development Report Card for the States*, published annually by the Corporation for Enterprise Development (CFED), Washington, DC.

A state's underlying development structure dictates how competitive it and companies within its boundaries will be, says Doug Ross, president of CFED. The report tabulates 23 economic indexes combined into four subindexes: human resources, technology resources, financial resources, and infrastructure.

Despite continual updates in these measures, state rankings do not change a whole lot from one year to the next. The results are largely unchanged, not because the indexes are insensitive, but because changes in a state's fundamentals take time. Economic investments are inherently long-term with slow payoffs.

This is often why states that seek highly visible short-term results, such as tax abatements, will experience long-term economic deterioration by postponing needed "invisible" improvements in infrastructure.

While many resources, such as technology, are critical to a state's economic growth, they alone cannot guarantee growth. States with strong technology assets, such as California, Massachusetts, and New York, have seen recent hard times. However, when the general economy turns around, these states, with their large pools of highly skilled technologists and strong R&D facilities, will be well positioned for future growth.

For a copy of the report: 202/408-9788. —*Tim Studt*

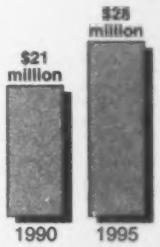
States Get Their Report Cards For Development Capacity

Rank		Human resources	Technology resources	Financial resources	Infrastructure
1	Minnesota	A	B	A	A
2	Washington	A	B	B	A
3	Utah	A	A	C	A
4	Massachusetts	B	A	A	C
5	Colorado	A	A	D	A
5	Connecticut	A	A	A	C
7	California	C	A	A	B
7	Delaware	C	A	B	A
9	Maryland	B	A	C	A
10	New Jersey	B	B	A	B
10	Pennsylvania	C	B	A	B

Source: Corporation for Enterprise Development

To assess development capacity, 23 measures, including R&D per capita, venture capital per capita, and utility costs, were combined to form the four subindexes shown.

Slow Growth for Rheometers



The market for torque rheometers will grow more than 6% annually through 1995 to $28 million, according to Strategic Directions Intl., a Los Angeles-based management consulting firm.

Rheometers are used primarily in the organic chemical, petrochemical, plastics, and pharmaceutical industries. Western Europe is the largest geographic region for rheometers, with 45% of the worldwide market.

Instrument Firms Help Find Funding

If your proposed research project entails buying new analytical equipment and you are involved in academic research, there are a few instrument makers that may be able to help you find a funding source.

GOW-MAC Instrument Co., Bridgewater, NJ, recently joined Spectra-Physics, San Jose, CA, and Nicolet, Greenbelt, MD, in offering free grant-assistance programs. Each com-

MODIL Integrates New Optics Technologies for SDI

Curt Maxey, an Oak Ridge (TN) National Laboratory engineer, operates a scanning Hartman device, which uses laser light to confirm the shape of diamond-turned optics to better than one-eighth wavelength.

This is one of several advanced devices installed at ORNL's Optics MODIL (Manufacturing Operations Development and Integration Laboratory). MODIL helps the U.S. optics industry increase its precision engineering capabilities by searching globally for new manufacturing technologies that could be used to produce advanced optical components for the Strategic Defense Initiative (SDI) program.

Ion Beam Focused To 8-nm Width

Focused ion beam (FIB) lithography is becoming an increasingly attractive way to achieve sub-100-nm feature sizes on advanced high-speed optical and electrical devices, because FIB widths are continuing to shrink. Randy Kubena and his associates at Hughes Research Labs, Malibu, CA, recently attained an FIB that's only 8 nm in dia, which is believed to be the smallest ion beam to date.

The team used a two-lens microprobe system and a single-isotope gallium ion source. The 50-keV system is essentially the same as that used at Hughes four years ago to achieve the previous ion beam record of 15 nm, which produced distinct lines as small as 12 nm in a thin layer of polymethyl methacrylate (PMMA) resist. The new 8-nm beam produces features as small as 6 to 8 nm.

The FIB's optical system was changed a bit to net the latest advance, Kubena says. "Essentially we ran the system with lower magnification. We decreased the object distance of the first lens and refocused the beam. Doing this decreased the chromatic aberration of the whole system, which let us reduce the spot size."

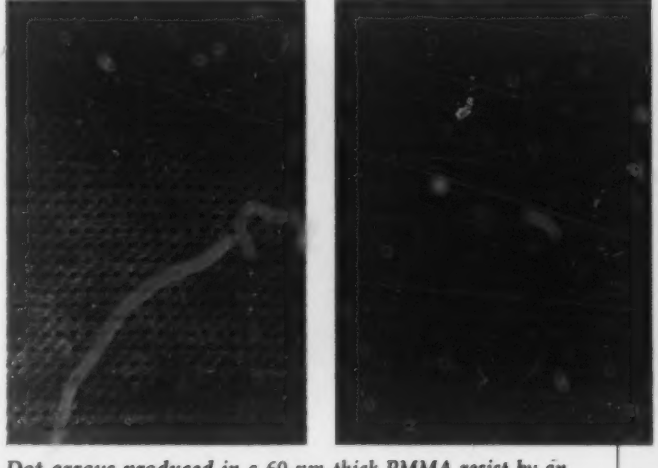
Monte Carlo calculations predicted that we should see energy broadening effects at a gallium ion exposure somewhere below 40 nm, Kubena says. "It was predicted that the effects might cause limits in the 20- to 40-nm range, and it was a little surprising that we could get down to the 10-nm range before we began encountering them."

Both dots and lines were made, and it was found that dot size varied greatly. "Because we were dealing with such small regions and were putting in a very few ions (under 20 ions/pixel), we were getting a large variation in dot sizes. With lines, which were made by laying down a series of dots very close together, there was less sensitivity, but still effects were seen.

"This indicates the need to develop a less sensitive resist for very small exposures of both dots and lines," Kubena says. Kubena's group is working on finding alternatives to PMMA, but details are proprietary at the moment.

Fabricating devices down to nanoscale dimensions calls for new approaches to facility design. For good results, not only is a cleanroom needed, but also a noise-free room.

"Any extraneous noise such as air conditioners or background noise in general can affect beam size. All of that must be addressed in utilizing these concepts," Kubena says. □



Dot arrays produced in a 60-nm-thick PMMA resist by an 8-nm-dia Ga^+ FIB. Dot size at right is from 10 to 20 nm.

U.S. High-Tech Exports Rise As Iron Curtain Crumbles

A dramatic increase in licenses for sales of technological goods to Eastern Europe by U.S. companies was due to political and economic changes inside the former East Bloc countries combined with an easing of U.S. export restrictions. Included are computers, machine tools, and aerospace products.

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